Albizia procera (Roxb.) Benth. White siris, Tall albizia

Leguminosae (Mimosaceae) Legume family

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HABITAT

Native Range

Albizia procera (Roxb.) Benth., the white siris or tall albizia, is a large, fast-growing deciduous tree found in moist forests at elevations up to 1200 m and on moist savannas in its native Asian range. Its natural range extends from latitudes 15° S. to 30° N., through India and Nepal, south and east of the sub-Himalayan tract and the Gangetic plain, continuing through the Andaman Islands, Bangladesh, Burma, southern China, Thailand, Kampuchea, Laos, Vietnam, Malaysia, Indonesia, the Philippines, Papua New Guinea, Melanesia, and northern Australia (*28,36*). White siris was introduced to the Virgin Islands at least a century ago and became naturalized in Puerto Rico after its introduction in 1924 as an ornamental and farm forestry species (*26*). Within its native south Asian range white siris is a well-known species widely cultivated along roadsides, field borders, and in agroforestry systems (*5, 16, 25*).

Climate

White siris can be found in tropical and subtropical moist and wet forest life zones where annual precipitation ranges from 1000 to 5000 mm with or without a pronounced dry season. Within its native range white siris develops best in areas with an annual rainfall of 2500 mm or more, as in Assam, Bengal, the Andaman Islands, and the Western Ghats in southern India. In the drier regions of the Indian peninsula, where rainfall is about 1000 mm, development is much poorer, with stem diameters rarely exceeding 50 cm (*36*).

The species is not very exacting as to temperature. In its natural habitat, maximum temperatures in the shade vary from 37 to 46 °C, and minimum temperatures range from 1 to 18 °C. Although white siris is susceptible to frost, it is reported to be fairly drought resistant (*35*).

Soils and Topography

White siris can be found on a variety of soils, although it grows best in very moist conditions on alluvial, well-drained loams or clayey soils (*8, 36*). Its ability to grow on dry, sandy, stony, and shallow soils makes it a useful species for afforestation of difficult sites (*27*). Very good survival and rapid early growth rates have been reported in afforestation trials on both saline and alkaline soils in Uttar Pradesh, India (*18*). Optimal soil pH for the species, however, ranges from 5.0 to 5.5, according to studies conducted at the Bangladesh Tea Research Institute (A.F.M. Badrul Alam, BTRI, Srimangal, Bangladesh; pers. comm.). It readily forms an association with *Rhizobium* spp., and the resultant nitrogen-fixing capacity enables it to thrive in nitrogen deficient soils (*1*).

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Associated Forest Cover

White siris is most commonly found on alluvial ground along streams and in moist, even swampy sites. In India it is dominant or codominant in the moist, mixed deciduous forest canopy under variable drainage conditions. Throughout low alluvial savanna woodlands in the Gangetic Plains and Brahmaputra Valley, these trees are found as scattered individuals or in clumps during early successional phases on young, generally sandy, alluvial soils (*5, 7*).

In the lowland savanna and riverain forests of Assam and Bengal, white siris is commonly associated with *Salmalia malbarica* (DC.) Schott & Endl., *Trema orientalis* Bl.,*Dillenia pentagyna* Roxb., *Terminalia bellerica* (Gaertn.) Roxb., and *Gmelina arborea* Roxb. (*10, 15*). In the moist savanna forests of Uttar Pradesh that are dominated by tall grasses, chiefly *Saccharum procerum* Roxb., white siris may be found with *Salmalia malabarica* (DC.) Schott & Endl. and *Bischofia javanica* L. (*36*).

White siris is common in the swamp forests of the sub-Himalayan hill tract, where it is associated with *Syzygium cumini* (Linn.) Skeels, *Diospyros peregrina* (Gaertn.) Gurke, *Ficus glomerata* Roxb., *Bischofia javanica* L., *Pterospermum acerifolium* Willd., *Cedrela toona* Roxb., *Celtis australis* Linn., *Trewia nudiflora* Bedd., *Putranjiva roxburghii* Wall., and *Salix tetrasperma* Roxb. (*36*).

In the mixed deciduous and evergreen hill forests of northeastern Bangladesh, white siris is found in the canopy as a codominant with *Dipterocarpus turbinatus* Gaertn., *Tetrameles nudiflora* R. Br., *Dillenia pentagyna* Roxb., *Salmalia malabarica* (DC.) Schott & Endl., *S. insignis* (Wall.) Schott & Endl., *Artocarpus chaplasha* Roxb., *Eugenia* spp., *Lophopetalum fimbriatum* Wight, and *Duabanga sonneratioides* Ham. (*3*).

In the riverain forests of Assam, where rainfall exceeds 2000 mm, white siris is associated with *Bischofia javanica* L., *Salmalia malabarica* (DC.) Schott & Endl., *Anthocephalus cadamba* Miq., *Elaeocarpus assamicus,* and *Lagerstroemia speciosa* (Linn.) Pers. (*36*).

In northern India's tropical mixed deciduous forests, common associates include *Terminalia* spp., *Lagerstroemia parviflora* Roxb, *Sturcularia villosa* Roxb., *Salmalia malabarica* (DC.) Schott & Endl., and *Gmelina arborea* Roxb. (*36*).

In Puerto Rico, where the species has become naturalized during the past 50 years, it is an agressive pioneer, forming pure stands along road embankments and abandoned farmland or on other physically disturbed sites in the subtropical moist life zone. It is also common in pastures at low elevations and along streambanks throughout the Island at elevations below 600 m where rainfall exceeds 800 mm.

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—In its native Indian range,

flowering takes place from June to September (*35, 36*); in Puerto Rico flowering takes place from August to October. Flowers are borne on racemes 8 to 25 cm long near the end of a twig. Numerous greenish-yellow flowers form whitish globose heads 20 to 24 mm in diameter. Individual flowers (6-7 mm) have a greenish 2-mm five-toothed calyx tube; a narrow, 4- to 5-mm whitish corolla; and five pointed, hairy lobes with many white threadlike spreading stamens about 10 mm long. The pistil consists of a narrow ovary and threadlike style (*26*).

The fruits, rich-red or reddish-brown flattened pods 10 to 20 cm long and 1.8 to 2.5 cm broad, are produced in large numbers and ripen from February through May in India and from January through June in Puerto Rico (*26, 36*). The mature brown pods, each containing 6 to 12 seeds, usually remain on the tree until the whole twig bearing the pods is shed (*26*).

Seed Production and Dissemination.—White siris seeds are small (4-6 by 5-7 mm; 17,600-24,000/kg), flat, elliptical to nearly orbicular, with a hard, smooth, greenish-brown leathery testa. Seeds may be released from the mature dehiscent pods while still attached to the tree or from wind-blown pods that later dehisce or decompose. Seeds are less subject to insect attack than those of *Albizia lebbek* (L.) Benth., a closely related species (*35*).

Seed Development.—Germination in white siris is epigeous. The seeds may be sown without treatment, although germination is facilitated if seeds are immersed in boiling water and then allowed to cool for 24 hours (*21*).

Seeds retain their vitality for at least a year and germinate readily in 3 to 21 days, provided there is sufficient soil moisture (*35*). Germination rates for freshly extracted seeds collected from various parts of the Indian subcontinent ranged from 50 to 95 percent. Seeds stored at room temperature for 15 years in India had a 20-percent germination rate. Seeds are readily extracted either by opening or crushing the pods by hand and separating them by winnowing (*36*).

Although white siris seeds germinate more readily in densely shaded areas than seeds of *A. lebbek* (L.) Benth., seedling mortality is high; in such areas seed may remain ungerminated until the second rainy season (*36*).

Under natural conditions, seedlings reach a height of 10 to 20 cm by the end of the first growing season and 60 cm by the end of the second. In the third year, the height ranges from 0.7 to 2.5 m, and by the fourth year height may reach 3.5 m (*36*). Under nursery conditions, if regularly weeded and watered, seedlings may reach heights of 30 to 50 cm within 3 months of germination and 1 to 2 m at 9 months (*24, 36*).

Seedlings are capable of withstanding moderate suppression and growth rates are slow until seedlings overtop competing vegetation. Vigorous seedlings produce a long, stout tap root that may reach a length of 60 cm 3 months after germination. Lateral roots are usually covered with *Rhizobium* spp. nodules (*35, 36*).

The natural regeneration of white siris is generally good. The factors favoring natural regeneration are plentiful moisture and bare, loose soil. During the rainy season large numbers of seedlings can be observed sprouting near seed trees. Seedlings in all stages of development may be found on soft alluvial ground near rivers in white siris' native range (*36*). In Puerto Rico, natural regeneration is extremely good, particularly in disturbed habitats such as road embankments and abandoned farmland, as well as in moist pastures at low elevations. On these sites, white siris appears to readily outcompete native tree species, forming pure stands with understory vegetation consisting mainly of grasses.

Under nursery conditions, seedling growth is favored by the absence of weeds, loose moist soil, sufficient soil moisture, and full sunlight. In India, it is recommended that seeds be sown in unshaded beds from March through May in rows about 20 cm apart. Seeds should be planted 5 to 10 cm apart in the rows and lightly watered for the first week. Two-month-old seedlings may be transplanted entire, with or without a ball of earth around the roots, immediately after removal from nursery beds. While transplanting is not difficult, direct sowing is generally the cheapest and most successful method, given regular weeding and loosening of soil (*35, 36*).

Plantations may be started by direct sowing, planting of seedlings, stem or root cuttings, and using stumps. Best results have been reported with direct sowing and stump plantings (*25, 27, 31, 35*). It is recommended that newly established plantations be weeded twice during the first year and once during the second. During weeding, soil should not be unduly exposed; only weeds directly interfering with seedlings should be removed (*36*).

Vegetative Reproduction.—White siris seedlings, saplings, and larger trees all coppice vigorously when damaged; vegetative reproduction also occurs through layering. Root suckers are readily produced when roots are exposed (*22, 32*). The application of the growth hormones IAA (indole acetic acid) and IBA (indole butyric acid) to stem cuttings in concentrations from 10 to 100 ppm has been reported to enhance rooting (*30*).

Sapling and Pole Stage to Maturity

Growth and Yield.—Growth of white siris is rapid. Under natural forest conditions in northern India, it may attain a girth of 1.2 m in 12 years and 1.8 m in 30 years (*8*), and heights of 25 m or more (*23, 36*). Mature individuals are characterized by a tall, erect, sometimes slightly curved bole, with large branches very high on the trunk and a spreading, thin crown. The bark is nearly smooth, light brown to whitish or light-greenish gray, exfoliating in thin flakes, with a red underside (*35*). Leaves are bipinnate, 12 to 25 cm long, with leaflets 2 to 4 cm long and 8 to 16 mm wide that are reddish when first produced.

In the mixed deciduous forests of its native South Asian range, white siris has been managed under the coppice system with a rotation of about 40 years. In Kerala, India, trees in uneven-aged stands are cut using a selection system. Although natural reproduction is generally good near seed trees, enrichment planting may be necessary for full stocking. In Bengal, plantations are raised for fuelwood on a 20-year rotation (*36*).

Average tree heights in an even-aged plantation in Bangladesh were 0.3, 0.8, 3.0, and 4.5 m at 1, 2, 4, and 5 years, respectively. In Burma, average heights in plantations were 12.8 and 22.9 m at 6 and 13 years, respectively. In Indonesia, average heights of 10.8, 14.0, 19.3, and 24.3 m were recorded in a plantation at 6, 8, 12, and 17 years, respectively (*36*).

In Burma, average stem diameters in an even-aged plantation were 16, 22, and 25 cm at 6, 13, and 18 years, respectively, with plantation densities of 313 trees/ha at 8 years and 200 trees/ha at 18 years. In Indonesia, average stem diameters of 10.5, 12.9, 17.4, and 22.4 cm were recorded at 6, 8, 12, and 17 years, respectively (*36*).

Total standing wood volumes of 65, 89, 127, and 151 m^3 have been recorded in an Indonesian plantation at 6, 8, 12, and 17 years, respectively, and, in an even-aged plantation in

Burma, standing wood volumes of 87 and 94 m^3 (including thinnings) were recorded at 8 and 13 years, respectively (*36*).

Average aboveground biomass yields from fertilized plantation plots established at Corozal, Puerto Rico, were 8.7 mg/ha (oven-dry) at 12 months and 64.8 mg/ha (including thinnings) at 24 months. These plots were established at an initial stocking rate of 10,000 trees/ha and thinned to 2500 trees/ha after 1 year. Soils at this site are acidic clays; annual precipitation is 2000 mm (*13*).

Rooting Habit.—White siris generally forms a wide-spreading lateral root system and a stout tap root. It appears to be a more deeply rooting species than *A. lebbek* (L.) Benth. and thus less subject to windthrow. As noted earlier, it readily forms an association with *Rhizobium* spp. and the resultant nitrogen-fixing capacity contributes to its ability to grow on marginal sites (*1, 27*).

Reaction to Competition.—*Albizia procera* is a light demanding species and cannot tolerate suppression. It can, however, stand moderate shade during the seedling, sapling, and small pole stage (*36*).

Damaging Agents.—White siris is reportedly susceptible to insect attack under plantation conditions in India. The principal insect pests in India include the hemipteran *Oxyrhachis tarandus* Fabr. (Membracidae), which attacks the young shoots of seedlings and saplings; the defoliating larvae of *Ascotis selenaria imparata* Walker (Geometridae), *Rhesala imparata* Walker, and *R. inconcinnalis* Walker (Noctuidae); and the bark-eating caterpillar *Indarbela quadrinotata* Walker (Indarbelidae). The red borer *Zeuzera coffeae* (Cossidae), a stem borer, attacks the woody stems and branches of saplings (*6, 36*). Approximately 50 other coleopteran, hemipteran, orthopteran, and lepidopteran insect pests of unknown importance have been reported to feed on young shoots, leaves, sap, seeds, and dead wood of white siris in south and Southeast Asia (*6*).

Young trees, whether growing naturally or in plantations, are highly susceptible to *Fusarium solani* (Mart.) Sacc., a highly virulent bark and stem disease causing the formation of stem cankers. These are associated with frost injury or branch breakage and initially appear as a longitudinal pinkish scar that enlarges, turning grayish black in the course of 4 to 5 years after secondary infection by bacteria and sap-staining fungi. The scar heals in dry weather and reopens with the return of rain. Secondary fungi and exposed sapwood provide breeding sites for the insect borers, further reducing tree vigor. The crowns may die above the canker or the stems may break at the place where the canker is deepest. Infected trees may eventually be wind-thrown. Trees 15 to 20 years old are particularly prone to attack, and the infection has been found in both the tree's native Asian range and the Caribbean (*4, 19, 26, 36*). The fungus *Nectria haematococca* Berk. & Br. has also been noted as the cause of stem cankers of young trees in India (*19*).

A number of rusts are known to attack *A. procera*, though none are of great importance. These include *Sphaerophragmium acaciae* (Cooke) Magnus and *Ravenelia sessilis* Berk. (both in south Asia and China), *R. clemensiae* Syd. (in India, Burma, and Papua New Guinea), *R. indica* Berk. (in India), and *Uredo albiziae* P. Henn. (in Papua New Guinea) (*19*).

The tree is also susceptible to a vascular wilt caused by *Fusarium oxysporum* Schl. f. sp. *perniciosum* (Hept.) Toole, which is perhaps the most serious and widespread fungal disease of *Albizia* spp. The fungus invades the fine roots causing a gummosis of the vessels; wilting and death of the host follows within a year of infection. Spread of the pathogen is mainly by transfer of infected soil; the fungus rarely sporulates on the host. The following fungi have been recorded as the cause of root and butt rot in white siris: *Ganoderma lucidum* ((W.Curt.) Fr.) Karst., *G. applanatum* (Pers. ex Wallr.) Pat. sensu lata, and *Polyporus anebus* Berk. (*19*).

Because the foliage of this species is highly palatable, it is subject to browsing by livestock, deer, camels, and elephants (*5, 36*). Branches of mature trees break readily in heavy winds (*36*).

SPECIAL USES

Within its native range, white siris is cultivated in home gardens, planted along roadsides and field borders, and used as a shade tree in tea gardens (*12, 33*). In the tea gardens of the Sylhet region of Bangladesh, however, the white siris is being replaced by *A. odoratissma* Benth. because of the latter's more rapid early growth and fuller canopy. *Albizia procera* is also more susceptible to stem canker disease and phytophageous red spider mites than *A. odoratissma*.

Several wood properties of this species make it a good all-purpose timber. The light-brown to light chocolate-brown heartwood is moderately hard (specific gravity: 0.6-0.9), straight-grained, strong, durable, and resistant to dry-wood termites (*26, 37*). It is difficult to saw due to its broadly interlocked grain; with care it works to a smooth surface and polishes well (*9, 36*).

In south Asia, the wood is used for a variety of purposes, including carts, boats, furniture, carving, posts, the manufacture of agricultural implements, bridges, house posts, boxes, rollers, wheels, sugar cane crushers, and rice pounders (*5, 14, 16, 29, 35*). The pulp of this species is considered a promising raw material for white writing and printing papers (fiber length: 0.90 mm; fiber diameter: 0.021 mm) (*20,34*). The wood is an excellent fuel, either as firewood or charcoal, and is used throughout the tree's range for this purpose.

In addition, secondary products can be obtained from the bark and stem of this species. The stem exudes large quantities of a reddish-brown gum when injured that is chemically similar to, and used as a substitute for, gum arabic (from *Acacia senegal* Willd.) (*2, 15*). The bark contains tannin and is used in India for tanning and dyeing. The bark is also used as sizing in the paper industry in Nepal (*2*).

Because the leaves and twigs are rich in protein and are a favorite of cattle, elephants, camels, and goats, the species is an excellent source of fodder (*17, 36*). White siris is also used extensively in traditional Indian medicine (*2, 5, 12*). The leaves are used in the treatment of ulcers (*16, 36*), and the bark is reported to be a strong poison (*5*). The leaves are known to have insecticidal and piscicidal properties (*11*).

GENETICS

Albizia is a large and extensive pantropical genus of 150 species, mostly trees and shrubs. Species are most numerous in the Old World tropics and are closely related to and often mistaken for *Acacia* spp. Botanical synonyms include *Mimosa procera* Roxb., *Mimosa elata* Roxb., and *Acacia procera* Willd. (*5, 16, 23*).

Most species in the genus are well adapted to poor soils and are common in low bush, in secondary forests, in savannas, and along sandy riverbeds up to 1600 m in elevation. *Albizia falcataria* (L.) Fosberg is one of the fastest growing trees in the world and is widely cultivated in Southeast Asia and the

Pacific as a source of timber, pulpwood, and fuelwood. Unlike *A. procera*, which is often found growing in regions with a pronounced dry season, *A. falcataria* grows robustly only in the wet tropics where rainfall is 2000 to 2700 mm/yr. On good sites with adequate rainfall, productivity of *A. falcataria* is greater than that of *A. procera*, with mean annual increments of 25 to 40 m^3/ha in an 8- to 12-year rotation. Under optimal conditions, trees may reach 7 m in height in just over 1 year, 13 to 18 m in 3 years, and 30 m in 9 to 10 years (*27*).

The genus is named for Il. Sig. Cavalier Filippo deg l'Albizzi, an 18th-century Italian naturalist of Florence (2).

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